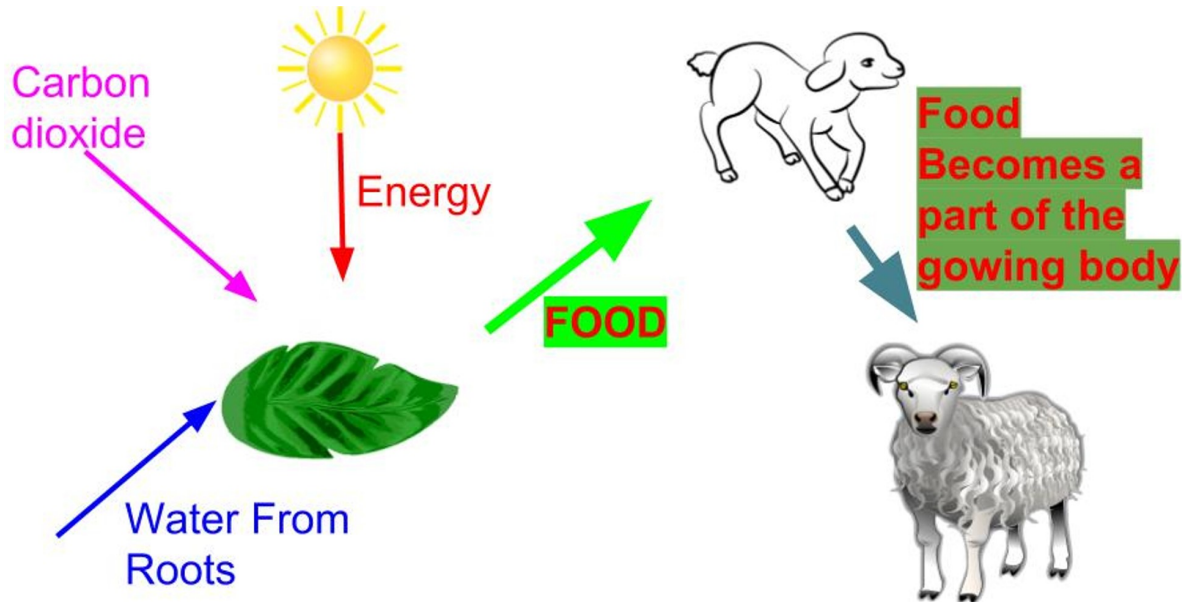
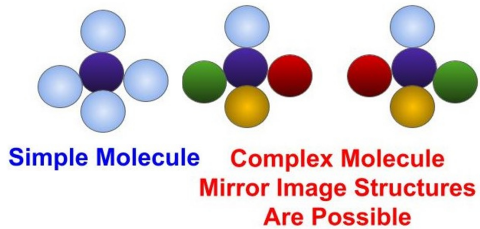


Molecules and mechanics of life

The plant grows only when it gets water, sunlight and carbon dioxide. A goat grows by eating the plant. {Picture below} In this simple process, molecules that are initially in air and water become molecules in the plant and later on the goat. But the atoms are the same. Their properties do not change. The atoms of sodium in the table salt and the sodium in the sun emit particles of energy of the same colour. Similarly, identical atoms in a stone and in a living body can participate in the same chemical reactions. The atoms do not have the ability to receive commands from god men. There has been no scientific evidence for miracles. Claims of such evidence are not justified.



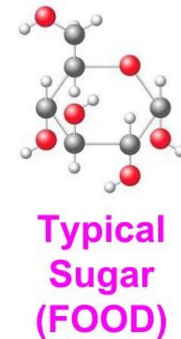
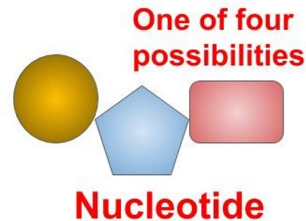


The carbon dioxide in the air becomes a part of the glucose molecule inside the living being. The glucose molecule in addition to being a bit bigger also has a property best called “handedness”. The molecule of carbon dioxide and its image in a mirror are identical. A glucose molecule and its image in a mirror are related to one another like the right and left hands.

The image of a right hand in the mirror is a left hand. This is “handedness”. A molecule of methane has no handedness. {Picture above left} But if instead of four identical hydrogen atoms, there are four different atoms, the molecule becomes “handed”. The molecule and its mirror image are not identical. The two are called L and D versions of the molecule. If molecules which have handedness are produced by ordinary chemical processes, 50% of the molecules will be of the L variety and the rest of the D variety. Most surprisingly, all living beings produce only one of the two varieties. All living beings use only molecules of one variety as food. This is a very

strong evidence that all living beings evolved from a common ancestor. All the bodies of all the more than ten million different types of living beings are made of just twenty different amino acid molecules. The genes of all living beings are similarly made of only four nucleotides. All living beings use a few molecules like glucose

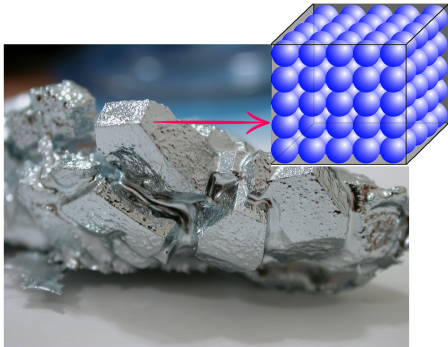
Amino Acid

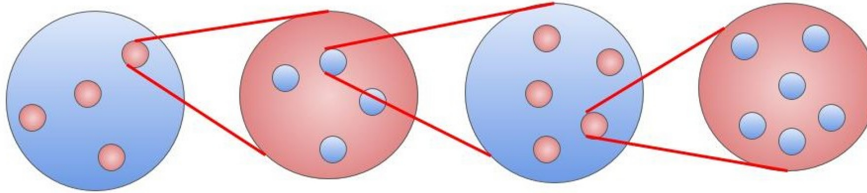


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made of hydrogen, oxygen and carbon, as the source of food and energy. All this is true of all the billion cells in the human body and the six hundred million nucleotides in the genes in each cell.

As the chick grows inside the egg, nothing other than a few gas molecules cross the shell. But the molecules inside organize themselves into a symmetric and highly organized living being. There are many examples of beauty and symmetry in non living nature. Snowflakes are a great example. {Picture below right} A large variety of beautiful patterns are visible. Large crystals form very easily in Gallium, a liquid metal at about 30°C. {Picture below left} Even more surprising is the symmetry in water at a temperature of 373.946°C and a pressure of 22.064 mega pascals. This combination of temperature and pressure is called the critical point of water. At the critical point, water exists in a curious mixed state of liquid water and steam. In every drop of water, smaller droplets of steam are seen. In every such droplet of steam, even smaller microscopic droplets of liquid water exist and the





Water At Critical Point
Bubbles of steam in water
Drops of water inside steam bubbles

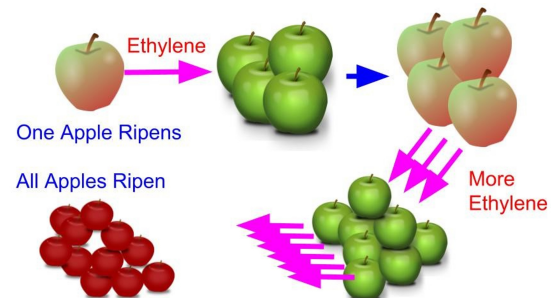
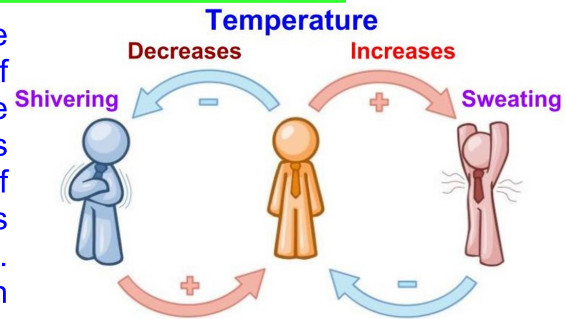
pattern repeats itself. The repeated change from the liquid water to steam is visible during microscopic examination is a wonder seen in non living matter. {Picture left}

The order and beauty in these non living materials is temporary. When the temperature slightly increases, the beautiful snow flakes and crystals of gallium melt. The order at the critical point is lost if the pressure or temperature change slightly. None of these materials have an ability to notice the change in the surroundings, react to the changes and retain the order. Only living beings can do so.

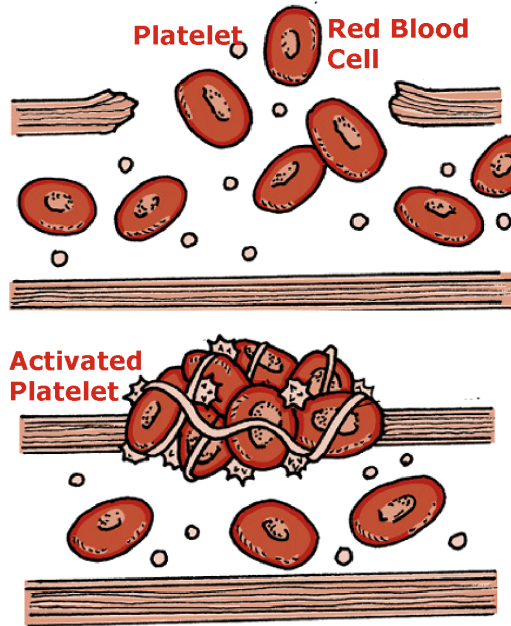
As an example, consider a long stick being balanced vertically on the palm. {Picture right} As the stick leans one way the hand moves in the opposite direction to keep the stick vertical. This is called negative feedback. The action of the stick in tilting in one direction is opposed by the movement of the hand. Response of the human body to changes in the temperature of the air in the



surroundings is another good example of negative feedback. {Picture right} When the temperature of the surroundings increases, the body temperature initially increases. Sweat forms which evaporates and cools the body, reducing the temperature of the body. If the surrounding temperature falls below the body temperature, the body shivers. This movement generates heat in the body which increases the body temperature. These feedback controls maintain the body temperature at a safe value even when the surrounding temperature has changed. Without this feedback survival is difficult. Negative feedback provides stability.



There are some examples of positive feedback in nature. The response to the action causes an increase in the action rather than decreasing it. For example, when one fruit in a tree starts ripening, it releases ethylene gas. This causes the neighbouring fruits also to ripen and they release even more ethylene gas. Very soon all the fruits on the tree {Picture above} or even on other trees in the orchard will ripen. Similarly, when there is a wound, cells in the blood called platelets release specific molecules. {Picture top opposite page} These trigger other platelets to release similar molecules and arrive at the wound. The platelets form a clot and stop the bleeding. In these two examples, positive feedback is beneficial to the living organism. But positive feedback does not create stability. Sometimes positive



feedback could be very dangerous. When exposed to extreme cold, shivering will not be able to prevent cooling the human body. When the body cools, the normal body functions become slower. This further decreases the body temperature. This is one positive feedback that can cause death.

Every living being has a very large number of positive and negative feedback loops supporting each other and life. Life is impossible without these. But every one of these feedback loops is due to chemical reactions between molecules. Thus, there are bound to be errors and accidents. No living being can live for an infinite time. In a human body for example, even while molecules from outside are becoming part of the body, cells are dying and being continuously replaced. So, the most important property of living beings is not the combination of feedback loops

which is called homoeostasis but the ability to produce the new generation. This ability has enabled life to survive on this earth for a very long time.

As we shall see, the environment on earth also has a large number of feedback loops. Even though the environment does not have the ability to reproduce, some people have claimed that the environment is also a living entity and named it Gaia. But this is emotional exaggeration and not science. It does not help the efforts to protect the environment either.
